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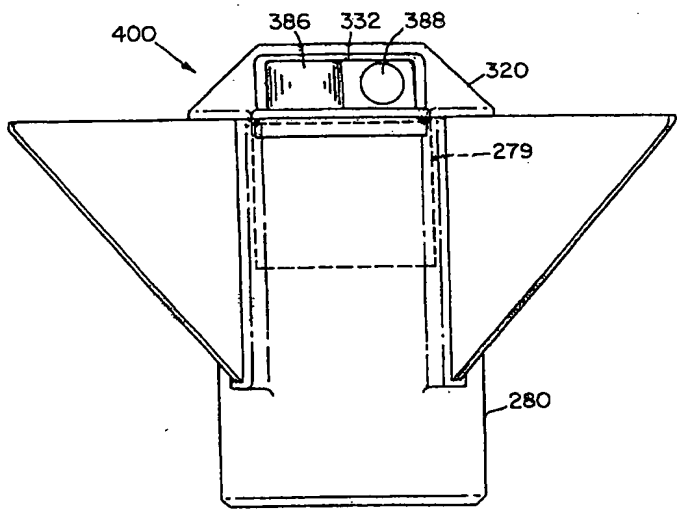

(57) Abstract

A precise and unambiguous traffic monitoring road video camera system includes a robust tightly enclosed housing equipped with a unique shutter, a CCD camera whose exact spatial position can be manipulated by fine probes, and a smooth, dome-like, capping that snag fits onto the housing of the camera. The entire system is embedded in a road opening, preferably at the center of each lane, at a small distance from the road sensors employed to determine adherence to various traffic laws. The road-embedded video camera system is in continuous communication with a central control and processing unit. When the processor determines that a vehicle was involved in a traffic violation it triggers the road video camera system to open its shutter and survey the immediate area outside. A suitable frame is then grabbed by the central processing unit for the purpose of preparing a traffic violation file.

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A ROAD-EMBEDDED VIDEO CAMERA SYSTEM

BACKGROUND OF THE INVENTION

In the modern traffic theater, it is often necessary to monitor and enforce traffic laws and regulations, and/or control access to restricted areas and localities. For example, monitoring a vehicle's speed is of utmost importance for a safe traffic arena.

One common method for enforcing the law on highways and byways is to employ police officers who monitor traffic manually and issue citations to violators when appropriate. Police officers make use of certain electronic devices, such as a laser gun, to determine a vehicle's speed. Other existing methods employ certain semi-automatic systems, such as a camera that monitors vehicles crossing an intersection through red traffic lights.

Video and still cameras are used in current systems to document traffic violations. Usually, the image of the vehicle thus obtained undergoes digital signal processing in order to retrieve the license plate registration number. This is then used to determine the owner of the vehicle. In certain cases, manual inspection of the picture is relied upon for retrieving the registration. These cameras may be operated manually by highway officers, or may be triggered automatically by a command received from a central control unit upon detection of a traffic violation.

When automatic operation is the method of choice, the system's camera is positioned such as to constantly survey a chosen segment of the road within the camera's field of view. The natural position for the camera is on either side of the road, close to an edge, and as close as practical to the exact location where adherence to the law is being monitored by an appropriate set of sensors. This minimizes the chance of a second vehicle coming into the camera's field of view while attempting to take a picture of the vehicle in violation of the law.

Typically, the distance between the camera and the sensors should be of the order of a car's length, which is also about the width of one lane on a typical highway. It turns out, then, that the angle of view towards the distant edge of the lane closest to the camera, is about 45°. Viewing the license plate at 90°, i.e., head on, is preferable in order to maximize the chances for a successful extraction of the registration number by an optical character recognition algorithm. However, a 45° angle is still adequate for this purpose in most cases. The situation becomes more complicated when there are multiple lanes in each traffic flow direction. For example, in an eight lane road with four lanes in either direction, with the camera positioned at a distance equivalent to a lane's width from the sensor, the view angle is 45° for the lane closest to the camera, dropping to 27°, then 18°, and then 14° for the second, third, and fourth lane, respectively. Clearly, such acute angles as the last two make it

extremely difficult, if at all possible, to obtain a legible reading of the license plate.

One common approach devised to mitigate the seriousness of this problem is to position the camera on top of a tall pole. This increases the separation between the sensor and the camera, and lessens the effect of a closely following vehicle which could block the view of the rear of the vehicle being monitored. Still, the improvement obtained by this solution is partial for obvious reasons. In addition, this is a costly approach; it is prone to acts of vandalism, and it is environmentally undesired in many locations.

Another serious problem, which is characteristic of present video camera road surveillance methods, is that of ambiguity in associating a given vehicle with the recorded traffic violation. Since all of the currently available methods rely on cameras positioned at the side of the road, it is not always possible to pinpoint one out of several vehicles that may show up in the image. This is particularly so when active sensing methods, such as laser and radar devices are used, since no physical record of the sensors being used may be seen in the image.

SUMMARY OF THE INVENTION

With the advent of VLSI technology in recent years, miniaturization of CCD video cameras has been realized and optical resolution has increased. These facts are pivotal for the present invention.

In many countries, border lines between lanes, and other road features of interest, are marked by small dome-like metal caps that are permanently attached onto the road surface. These metal devices also house small reflecting devices, not unlike cats'-eyes, meant to increase awareness to road markings at night. These structures are typically 4" to 5" long on a side, and are equipped with beveled edges where the reflecting "cat-eyes" are fixed.

We rely on the experience gained over many years in many countries and localities where use has been made of these road features, and provide a new video camera ensemble whose top surface appearance is similar to that of these well known devices. A small video camera system is inserted into the top road layers, housed in a suitable enclosure comprised of a cylinder or box housing that is permanently fixed in the pavement, and protected from traffic and weather by a metal cap that is screwed, or otherwise attached, to the fixed housing. The enclosure has a small opening near its top pointing in the direction of traffic flow to enable communication between the camera and the road scenery in front of it. In a preferred embodiment, the cap has an opening in the direction of traffic such that upon opening a shutter the lens of the camera communicates with the outside world.

Inside the fixed housing in a preferred embodiment, the camera is mounted to a holder, furnished with means for moving and aligning the camera so as to provide it with the proper view angle. In addition, a solid shutter and

shutter mechanism are provided inside the cap to ensure tight closure of the camera system at all times, except when it is desired to monitor the traffic on the particular lane of the road. The shutter is activated by either a pneumatic or an electromechanical mechanism, and it may possibly use other fast means for opening and closing the tight camera housing, such as provided by certain mechanical and spring-loaded devices. Finally, the camera housing may be further equipped by cooling means, such as a suitable fan forcing air through suitable pipe openings. The latter may also be used for power and communication cables.

To summarize, the present invention teaches the construction of a small, autonomous, road video device. This novel camera complex includes robust housing and capping elements where provisions are made for the camera housed inside to be in direct communication with the outside road theater. The camera can be raised, rotated, and tilted on its axes so as to ensure adequate gazing angles when the shutter of the housing is open. In a preferred embodiment, this camera system is installed at the center of each lane just before the line where the road sensors are situated. Preferably, the camera is aimed at targets found at a distance of between 1 and 3 meters in front of the first road sensor, and positioned at the center of the lane. Using this distance range, a shutter window which is about 2 centimeters high will give rise to a gazing angle of about 15°. This is sufficient to obtain a full picture of the rear of the vehicle, which has just

traversed the set of sensors in front of the embedded road camera, and was determined to be in violation of some traffic law or regulation. Needless to say, determination of a traffic violator in this manner is uniquely unambiguous as the camera is looking straight forward, and in the short distance between the embedded road camera and the road sensors it is highly unlikely that another vehicle can squeeze in and appear in the same image.

The present invention is directed to an automatic video camera system that is embedded in the road pavement, and is in continuous communication with a central command, control, and processing unit. The camera is housed in a tightly sealed enclosure, which is built into the road top layers so as to prevent any shock damage to its mechanism. A shutter that is part of the enclosure is opened upon command from the central processing and control unit. While this shutter is open the camera actively surveys the front scenery to record details of a traffic violation that was detected by the road sensors and communicated to the central processing unit. A frame grabber located in the central processing unit is activated by a prescribed algorithm to capture a chosen frame of the view seen by the camera while the shutter is open.

The road video system includes a robust enclosure equipped with a small window and shutter mechanism, a metal cap of appropriate dimensions and design attached on top of the road enclosure housing the various components of the camera and support gear, a holder at the cap's center which

allows exact positioning of the camera that is attached to it, a CCD camera mounted to the holder and able to move on one of its axes in order to tilt in the direction of the road scenery, a pneumatic or electromechanical mechanism for activating the shutter, and a cooling unit.

The placement of the road video system in the pavement proceeds as follows. A suitable pit is dug or drilled in the road and the enclosure is first fixed in this hole with the aid of epoxy resin, concrete, or other suitable construction materials. The bottom part of the enclosure, apart from the cap, is of such height that upon positioning in the hole its top rim is level with the pavement. The inner surface of the enclosure is fixed with appropriate means to enable tight attachment of the capping. Once the resin sets in and is hardened the various parts that control the functioning of the system are inserted and adjusted in place. In particular, attention is paid to the right tilt angle of the camera itself, so as to be able to gaze through the shutter's window and cover the right portion of the road's lane in which center it is preferably placed. Finally, the cap is screwed in to the enclosure's housing, or otherwise attached, such that its front is aligned with that of the shutter.

As a vehicle passes over the road video system, the vehicle encounters the road sensors which are in continuous communication with the central control and processing unit. Signals from these sensors are analyzed by the central processing unit, and a determination is made as to whether

the vehicle has engaged in violation of the particular traffic law being monitored by this particular system. If so, the road video system is activated and a record of the violation is made as described above. The picture that is captured and sent to the processing unit is analyzed in order to extract the registration number, and the entire file containing details of the event is sent by wire, or wireless means, to the headquarters where a citation and/or a summons to court is issued.

In a preferred embodiment the enclosure housing the camera gear is a steel cylinder approximately 15 cm in diameter and 20 cm in height. The inner surface of the cylinder is threaded such as to allow screwing in the cap used as a cover. Alternatively, this wall may be equipped with features allowing long screws to be inserted from the top side of the cap and screwed in to tighten the cover in place. At the side following the direction of traffic the enclosure has a window, or opening, about 5 cm wide and 2 cm high. Inside the cylinder a shutter of appropriate dimensions is devised to tightly close this window when there is no demand to survey the front area of the road video system. This shutter is typically made of steel, and is about 5 cm wide and 10 cm high. The shutter is connected to a mechanism that affects its movement up and down or sideways according to the need to have the window open for the camera to survey the front area. This may be an electromechanical, pneumatic, or any other suitable mechanism. The shutter protects the camera and any transparent window from the environment. It protects the

unit from vandalism and prevents dirt buildup which would obstruct the field of view.

The camera inside the enclosure is a CCD-type camera of appropriate dimensions to fit into the small enclosure. Typically, such camera would be 2 cm x 4 cm x 4 cm in size. The camera's resolution should be sufficient to obtain a legible record of the rear of a vehicle found at a distance of between 2 m and 5 m. Typically, the resolution would be of the order of 640 x 480 pixels. The camera is further equipped with a flash unit to allow for continuous operation regardless of the time of day and weather conditions.

In a preferred embodiment the entire camera gear is permanently attached to the enclosure's cover cap and is set precisely to desired specifications in the factory. All that is needed in this case in order to activate the road video system is to plug in the power and ventilation cables and hoses and place the cover in place firmly. This embodiment is preferred for its ease of installation and servicing.

In another embodiment, the camera rests on a small pedestal, or table, that is attached permanently to the floor of the cylindrical enclosure. This camera holder can be moved sideways, as well as up and down, to enable precise positioning of the camera relative to the shutters window and the desired outside view.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. 1A is a schematic representation of a cross-section along the road's width at the point where the road video system is installed.

FIG. 1B is a an enlargement highlighting the main features of the components that make up the road video camera system.

FIG. 2A is a schematic top oblique view of one prior art embodiment of an integrated traffic law enforcement system aimed at monitoring vehicle's velocity and unlawful overtaking at a solid divide line. The top cover of the road video system is seen on the two opposite lanes.

FIG. 2B is a schematic top oblique view of an embodiment similar to that depicted in FIG. 2A but showing the embedded road camera of the present invention.

FIGS. 3A and 3B show a cross-section and top view respectively of a preferred embodiment's housing with anchoring fins.

FIGS 4A, 4B, 4C and 4D show a bottom, side, front and top view respectively of the preferred embodiment's cap.

FIGS. 5A, 5B and 5C show a top, side and bottom view respectively of the preferred embodiment's camera gear mounting plate.

FIG. 6 is a drawing showing a side view of the camera gear mounting plate with a camera, flash, prism and fan mounted to the plate.

FIG. 7 is a drawing showing how the cap fits onto the housing and how the camera gear sits inside the housing.

FIG. 8A is a drawing similar to FIG. 7 showing the shutter in its open position. FIG. 8B is the same view but with the shutter in its closed position.

FIG. 9A is a drawing showing an alternate embodiment in which the camera has a direct view through the cap shutter.

FIG. 9B is a drawing showing an alternate embodiment similar to that of FIG. 9A but for a different camera requiring a different mounting plate.

FIG. 9C is a drawing showing an alternate embodiment in which the camera rests on a table and looks up at a prism or mirror.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1A is a schematic cross-sectional view of one embodiment of the road video camera system of the invention. The road pavement 27 includes at least two opposing lanes. Vehicle 30 is seen over camera system 270 on one of these lanes. FIG. 1B is a detailed cross sectional view of one embodiment of the road video camera system 270 in the road pavement 27.

The opening in the road, 28, where the camera system is positioned is in the form of a cylindrical hole formed in the smooth road pavement 27 that rests on the road foundation 29, as depicted in FIG. 1A. The foundation can be of any type common in road construction, and the pavement, likewise, can be made of concrete, asphalt, or any other suitable material. In the embodiment of FIGS.1A and 1B, the opening is made in the pavement material preferably at the center of the lane. In a preferred embodiment, the width of the road opening 28 can be within the range of 5 cm to 30 cm and is preferably within the range of 8 cm to 18 cm.

The housing 280 is embedded in the road opening 28, such that it is either level with the top surface of the pavement, or leaves a small depression in the road. As is shown in FIG. 1B, in a preferred embodiment the housing is level with the top surface of the pavement, in order to result in tight closure by the cover cap 272. In order to anchor housing 280 inside the road opening, any one of several suitable materials, such as concrete, asphalt, resin, etc. can be used to fill road opening 28 around and beneath the housing. In one embodiment of the present invention, additional anchoring is provided by fitting the outside surface of housing 280 with three or four fin elements 282 that are then embedded in the concrete that surrounds the housing to form a tight anchor.

In a preferred embodiment the housing 280 is a suitable metal cylinder. The outer diameter of this

cylinder is smaller than the width of opening 28. Specifically, the outer diameter of housing 280 can be within the range of 8 cm to 25 cm and is preferably within the range of 10 cm and 15 cm. The inner diameter should be such that camera 2700 can be inserted and placed comfortably, while maintaining adequate strength against shock waves and pressure exerted by heavy vehicles moving on the road. In the preferred embodiment the inner diameter can be within the range of 7 cm to 24 cm and is preferably within the range of 9 cm to 14 cm.

The camera can be of any type but is preferably of the charge-coupled device (CCD) type. Specifically, camera 2700 can be chosen among the group of such devices having various optical characteristics such as focal length, aperture, and detector area. In addition, camera 2700 can be chosen among the group of hard-wired or wireless devices. Camera 2700 can be further equipped with a tilting mechanism that allows fine adjustments about its axis perpendicular to the road along its length in order to assure proper forward gazing angle. Conduit 275 provides power and signal cables, as well as ventilation.

FIG. 2A is a top oblique view of the prior art road sensor system described in U.S. Patent Application No. 08/684,944 herein incorporated by reference, showing road segment 20 together with an automatic traffic monitoring system 50 that is integrated with sensor system 10a. Road segment 20 includes at least one lane in each traffic direction illustrated by arrows 271 and 272. Solid divide

line 24 separates traffic directions 271 and 272. Monitoring system 50 includes processor unit 52, conventional video camera 54, communication unit 56, and inter-wiring system 58. The sensing system layout 10a includes sensors s1 and s2 in traffic direction 271 identified by reference numeral 11 and 12, respectively, and sensors s3 and s4 in traffic direction 272 identified by reference numerals 13 and 14, respectively. Operation of these sensors is described fully in U.S. Pat. Application No. 08/684,944. It will be obvious to one having ordinary skill in the art that other types of vehicle sensors will work as well.

FIG. 2B is a top oblique view of a road sensor system similar to that shown in FIG. 2A but using the present invention's embedded road video camera system 270. The integrated traffic monitoring system of either FIG. 2A or FIG. 2B can be used to monitor such parameters as vehicle's speed, distance between following vehicles, and unlawful crossing of the solid divide line 24.

When a vehicle travels on road 20 along traffic direction 271 its front wheels first contact sensor 11 and then sensor 12. Upon the impact with sensor 11 a signal is recorded by processor unit 52 and analyzed to determine the impact time, t1. When the front wheels of the vehicle impact, next, with sensor 12, impact time, t2, is similarly determined. Processor unit 52 then determines the vehicle's velocity by dividing the known distance between sensors 11 and 12 by the time difference, t2-t1. Similarly, the system

determines the precise times at which the rear wheels pass over sensors 11 and 12 and uses these data to calculate the acceleration, if any.

The processor unit also uses data on vehicle velocity and the time interval that elapses between two consecutive events to determine the distance between following vehicles. The results regarding the velocity and distance between vehicles are then compared to allowable values. If any one parameter is in variance with the allowed value, the processor grabs the relevant frame from the road video camera system 270 of FIG. 2B. The image of the front or rear of the vehicle is then analyzed using a suitable algorithm aimed at extracting the license plate registration number. A file containing the data on time, location, nature of traffic law violation and relevant parameters, registration number, and the image of the vehicle is then prepared and transmitted via communication device 56 in FIG. 2B to a central processing and control unit where vehicle ownership is determined and citations issued.

The road video camera system of the present invention provides tremendous improvement over existing art shown in FIG. 2A. In the existing art, camera 54 is positioned along side of the road. Camera 54 is never able to capture a frontal image of the vehicle. Rather, as explained in the Summary, a certain view angle that is always smaller than 90° is involved. The value of this acute angle depends on the number of lanes and their width, the farther lanes from

camera 54 posing the most serious problem. The more acute this angle is, the more debatable is the content of the captured view of the surveyed traffic arena. In addition, license plate analysis becomes very difficult as the picture of a vehicle traveling on farther lanes becomes increasingly illegible. In contrast, the road video camera of the present invention is always directed head-on at the front or rear side of the vehicle. Hence, not only is the captured view free from any ambiguity regarding the identity of the vehicle involved in the traffic violation, but also the task of extracting the registration number is immensely simplified owing to the clear head-on record of the vehicle's front or rear ends.

Another major advantage over the prior art is that the road video camera system eliminates the need to install environmentally unfriendly tall poles. In addition, the fixing of the enclosure to the road makes it virtually invulnerable to vandalism as compared to cameras installed at roadsides.

In a preferred embodiment, the camera enclosure comprises three components: a housing which is embedded into the pavement, a cap which attaches to the top of the housing and protrudes above the road surface, and a camera gear assembly.

FIG. 3A shows a cross-section of the housing 280 in which two of the four anchoring fins 300 can be seen. Two holes 303, 304 are provided in the side of the housing.

One hole 303 is used to provide power and other electrical signals to the system as well as venting hot air out of the housing. The second hole 304 provides an air return.

FIG. 3B shows a top view of the housing 280. Four threaded holes 306 are used to attach the cap (not shown). Another hole 305 matches a pin in the cap to ensure that the cap can only be mounted one way.

FIGS. 4A-4D show bottom, side, front and top views respectively of the cap 320. Holes 322 line up with threaded holes 306 of the housing so that the cap may be secured with appropriate screws 334. Pin 324 must line up with hole 305 in the housing. Circular groove 326 provides a narrow groove into which an O-ring is fitted in order to provide a seal between the cap and the housing. Protrusions 328 align the cap to the housing. Three threaded holes 330 provide mounting for the camera gear assembly. Window 332 provides the opening through which the flash unit and camera communicate with the outside scene.

FIGS. 5A, 5B and 5C show top, side and bottom views respectively of the preferred embodiment's camera gear assembly mounting plate, which is mounted to the cap with appropriate screws through holes 382 in the plate and matching holes 330 in the cap.

FIG. 6 shows another side view of the camera gear assembly mounting plate with a camera 382, flash unit 386,

light deflector 388 such as a prism or mirror, and fan 384 mounted to the plate 380. In the pictured embodiment, the fan 384 is mounted via standoffs 390. The camera 382 is mounted such that it communicates with the outside world indirectly via the light deflector 388.

FIG. 7 shows a front view of the enclosure 400 with the cap 320 fitted onto the housing 280. Flash unit 386 and prism 388 are visible through the window 332, i.e. the shutter is open. The camera 382 and fan 384, which sit inside the housing, are shown in dotted lines, as are power and ventilation holes 303, 304.

Shutter 279, shown in FIGS. 8A and 8B, must assure a tightly closed system except for short periods of time when a traffic violation is detected by the sensors in front of the road video camera system. Shutter 279 may move up and down or sideways, depending on the mechanism chosen to control its position. If it were deemed preferable for shutter 279 to move in the vertical direction up and down, then cover cap 320 should preferably include on its inner surface a set of two rails, or notches, to ensure that shutter 279 locks in place tightly when it is pushed to its upward position, as in FIG. 8B. On its inner surface shutter 279 may be equipped with a small brush, or some other soft material, positioned so that whenever it moves, the brush wipes out any dust particles that may accumulate on the light deflector 388, or the lens of camera in the embodiment where the camera has direct view. To further protect the lens of the camera, the camera itself can be

fitted with its own shutter that would be opened and closed in tandem with shutter 279. The shutter mechanism may be chosen among the group of electromechanical, pneumatic, and mechanical mechanism, but is preferably of the electromechanical type.

FIG. 9A is a drawing showing an alternate embodiment 410 in which a particular camera 412 has a direct view through the cap shutter 416. Note that each type of camera may require a unique mounting plate. For example the camera 412 shown in FIG. 9A requires mounting plate 414. On the other hand, as FIG. 9B shows, a different camera 422 may require a different mounting plate 424.

FIG. 9C shows an alternate embodiment 430 in which the camera 432 is resting on a table 434 and looks up at a prism 438 or mirror (not shown) which deflects incoming light 440 down into the camera. The position of the camera may be adjusted by a vernier 436.

EQUIVALENTS

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. Those skilled in the art will recognize or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention described

specifically herein. Such equivalents are intended to be encompassed in the scope of the claims.

For example, the various embodiments of the road video camera system described above include different layouts and arrangements of the components used to assure a smooth and reliable operation. It will be understood that other types of components, designs, and layouts are possible for this applications. For example, the camera may rest on the table or pedestal with its lens facing the cover cap, while a mirror placed at an angle of 45°, or alternatively, a prism, allows the camera to record the scenery outside.

CLAIMS

What is claimed is:

1. A video camera system for use in automatic systems that monitor traffic flow and adherence to traffic laws and regulations comprising:

an enclosure installed in a road's top layers, said enclosure having a top end;

a camera placed and adjusted inside the enclosure; and

a cap forming the top end of the enclosure, said cap having a window to allow the camera to survey its immediate vicinity.

2. A video camera system as in Claim 1 wherein said window is normally closed by means of an automatic enclosure shutter mechanism protecting the window from the environment.

3. A video camera system as in Claim 2, further comprising:

an integrated event recording and reporting system in direct communication with the camera and automatic shutter mechanism comprising:

a processing unit,

a road sensor system, and

a communication module, wherein detection of a vehicle causes the road sensor system to generate a signal, said signal causing the processor unit to

determine whether to open the enclosure shutter to allow the camera to capture an image of the vehicle and to communicate information and the image to a separate control unit by means of the communication module.

4. The video camera system of Claim 2 wherein a hole is made at the center of one or more lanes of the road and an enclosure unit with camera and cap is installed in the hole.

5. The video camera system of Claim 2 wherein the enclosure shutter comprises an inner surface, a small brush being attached to said inner surface such that as the enclosure shutter moves, the brush wipes away any dust particles which may have accumulated on the window.

6. The video camera system of Claim 2 wherein the enclosure shutter is driven electromechanically.

7. The video camera system of Claim 2 wherein the enclosure shutter is driven pneumatically.

8. The video camera system of Claim 2 wherein the enclosure shutter is driven mechanically.

9. The video camera system of Claim 2 wherein the camera further comprises a camera shutter electrically connected to the enclosure shutter mechanism such that

the camera shutter opens and closes in tandem with the enclosure shutter.

10. The video camera system of Claim 1 wherein the camera is hard-wired.

11. The video camera system of Claim 1 wherein the camera is wireless.

12. The video camera system of Claim 1 wherein the road video camera system comprises a metal enclosure.

13. The video camera system of Claim 1 wherein the road video camera system comprises an opening in the road at or close to the border line between two lanes.

14. The video camera system of Claim 1 wherein the camera gear includes verniers to allow fine positioning in horizontal and vertical directions.

15. The video camera system of Claim 1 wherein the outer diameter of the enclosure is in the range of 8 to 16 centimeters.

16. The video camera system of Claim 2, said cap being beveled or rounded, protruding from the top surface of the road, and having an opening to allow the camera to survey the outside area when the enclosure shutter is open.

17. The video camera system of Claim 16, wherein the cap has a height in the range of 0.5 to 5 centimeters.

18. The video camera system of Claim 16, wherein the cap has a height in the range of 1 to 2.5 centimeters.

19. The video camera system of Claim 1, the enclosure having anchoring fins.

20. The video camera system of Claim 1, wherein the enclosure comprises a housing, the top of which is fitted with screw holes to allow tightening of the cap onto the canister by means of suitable screws, and wherein the cap is further equipped with a pin which inserts into a companion hole in the top of the housing such that the cap rests in only one position.

21. The video camera system of Claim 1, wherein the camera looks directly through the opening in the cap.

22. The video camera system of Claim 1, further comprising a deflector mounted in the cap, wherein the camera looks up at a deflected image in a mirror or prism.

23. The video camera system of Claim 1, further comprising a fan in the enclosure.

24. The video camera system of Claim 1, further comprising a flash unit electrically connected to the camera.

25. A video camera system for use in automatic systems that monitor traffic flow and adherence to traffic laws and regulations comprising:

a metal cylindrical housing with anchoring fins and suitable holes for venting and allowing power and signal cables to enter into the housing, said housing installed in a road's top layers;

a cap, said cap attaching to the housing and protrudes above the road's top layers, said cap having a window, said window being normally closed by means of an automatic shutter mechanism protecting the window from the environment;

a camera gear holder, said holder attaching to the cap, and holding in place behind said window a light deflector; and

a camera, said camera attaching to the holder, said camera also having a lens, and being oriented such that light entering through the window is deflected by the light deflector into the camera lens.

26. A video camera system as in Claim 25 further comprising:

a flash unit attached to the camera gear holder; and

a fan attached to the camera gear holder.

27. A method of monitoring and recording traffic flow and traffic-law violation events comprising:

providing road sensors and an integrated road-embedded video camera system in communication with a central processing unit, the video camera system comprising cameras positioned within road openings;

utilizing the impact of the wheels of a moving vehicle with the road sensors to trigger a computing process in the central processing unit to determine the nature of the traffic event; and

issuing an automatic report and citation to traffic law violator based on output of the road sensor and video camera.

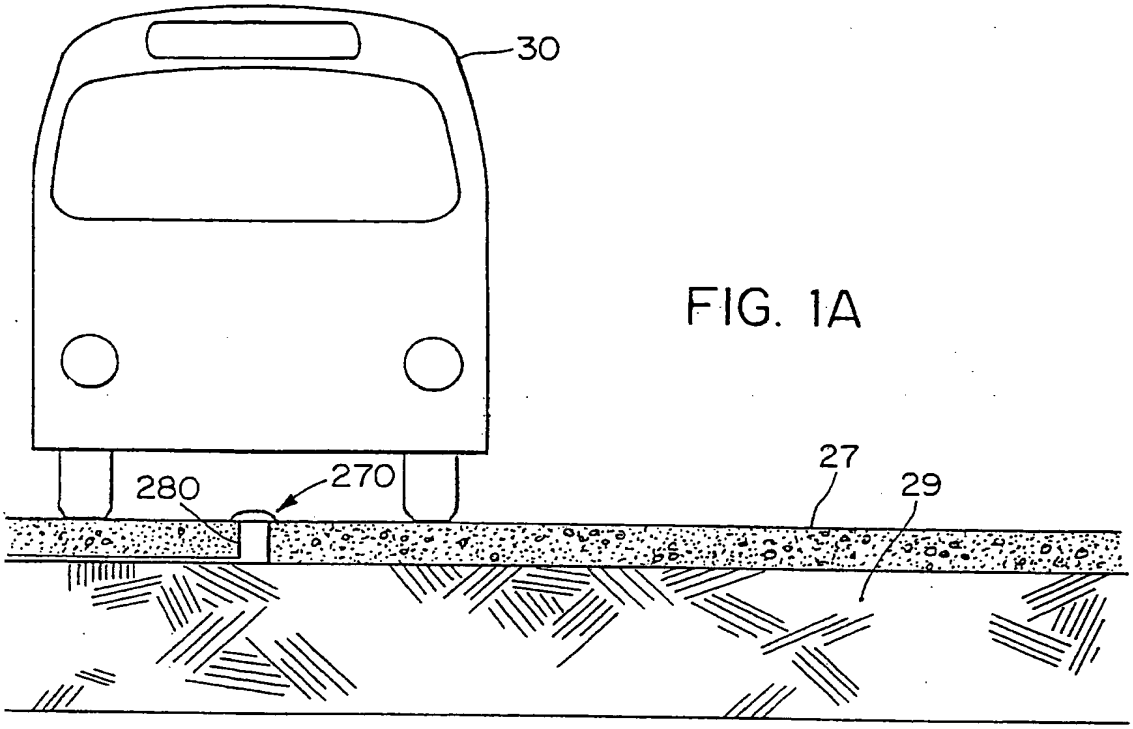


FIG. 1A

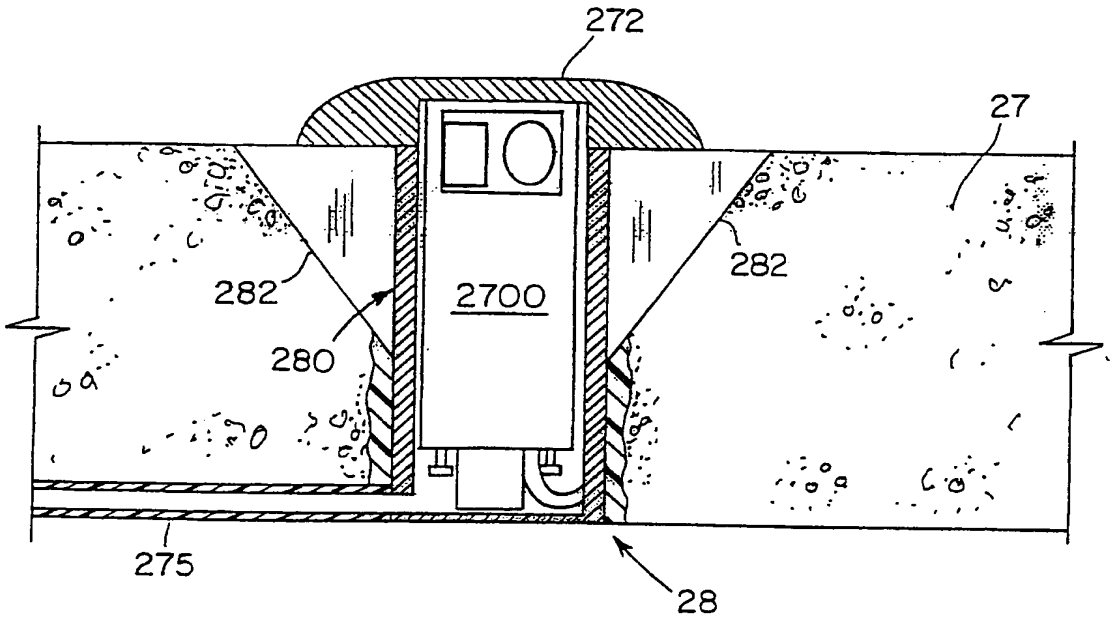


FIG. 1B

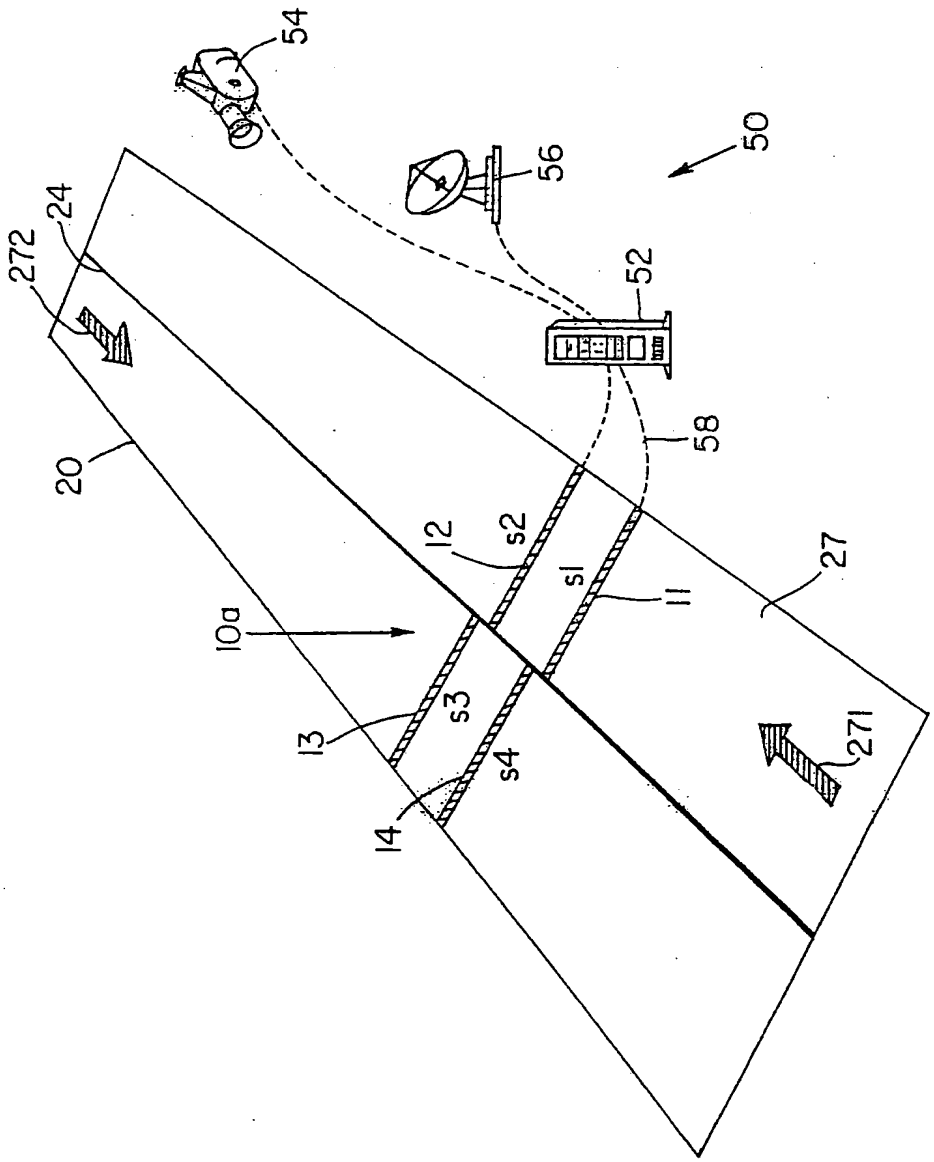


FIG. 2A (Prior Art)

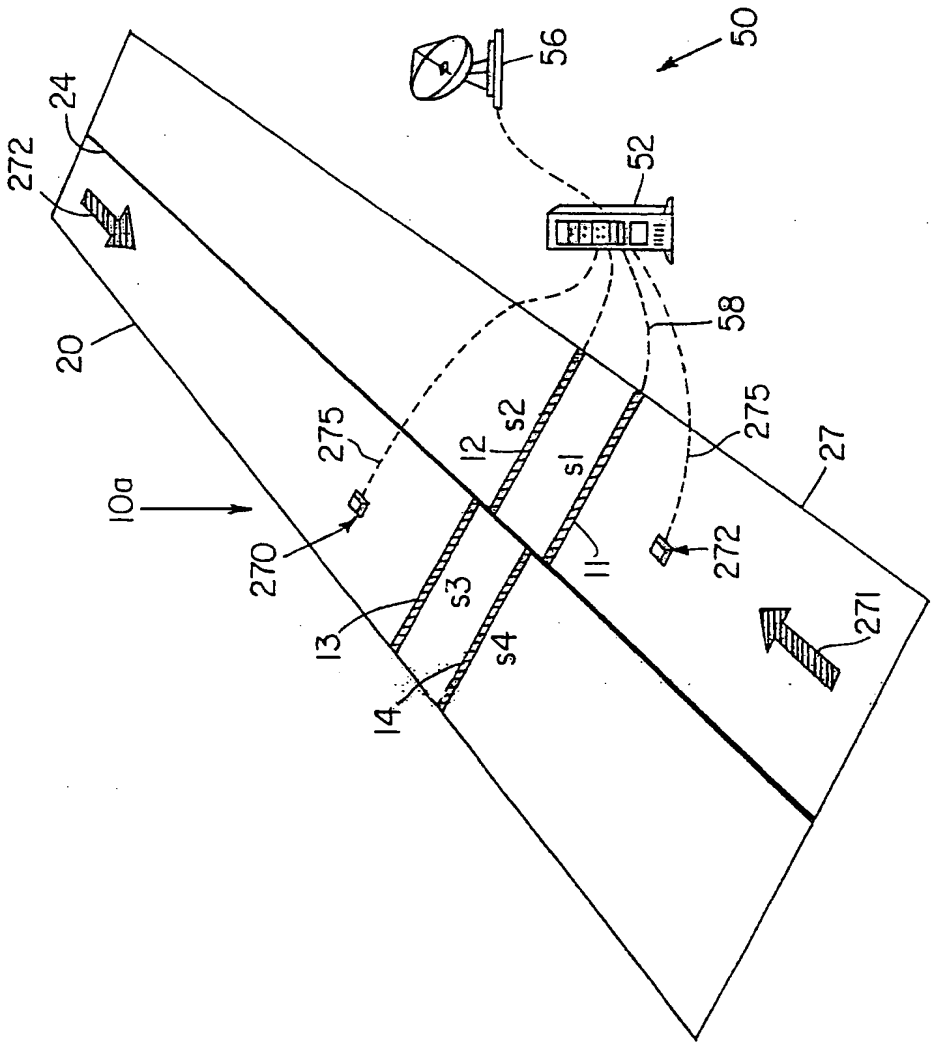


FIG. 2B

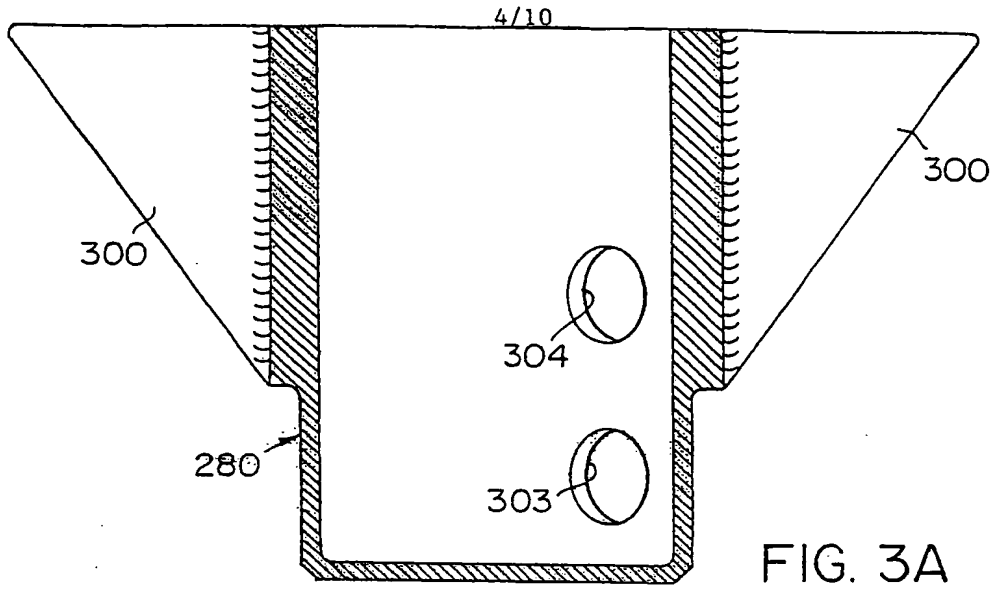


FIG. 3A

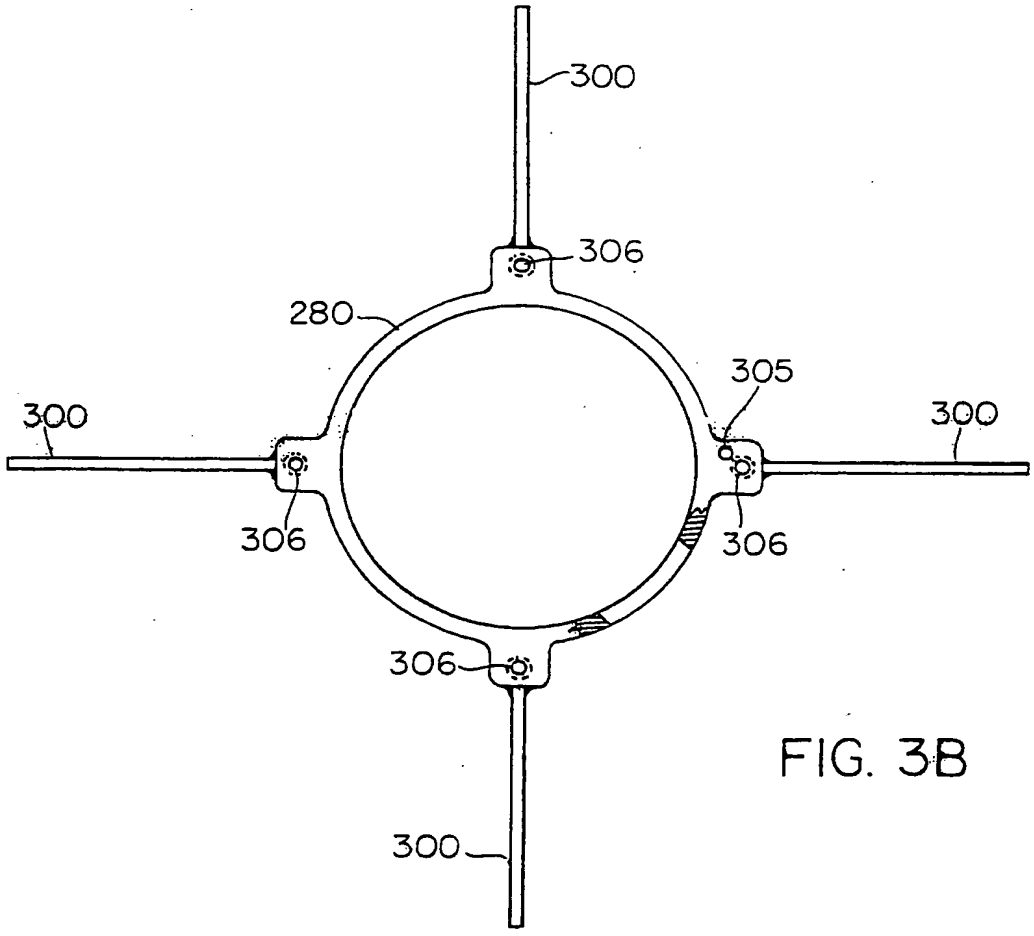


FIG. 3B

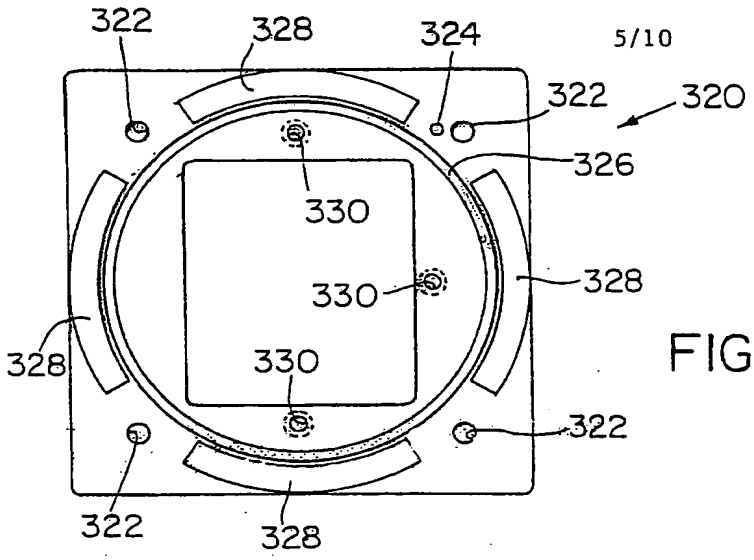


FIG. 4A

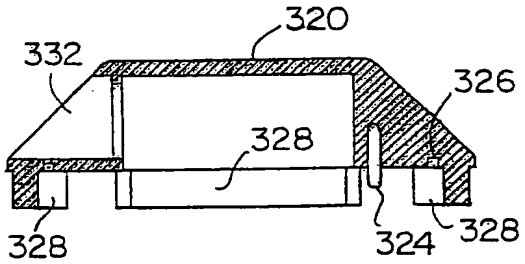


FIG. 4B

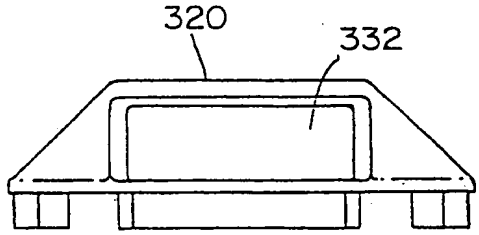


FIG. 4C

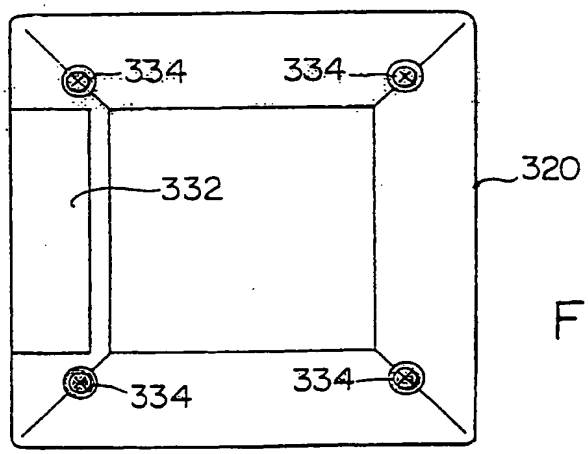


FIG. 4D

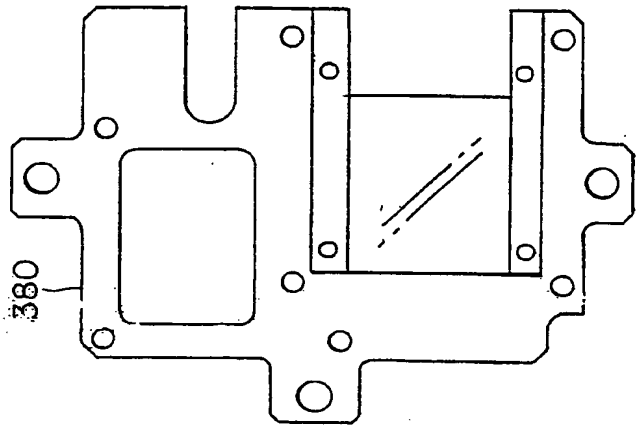


FIG. 5C

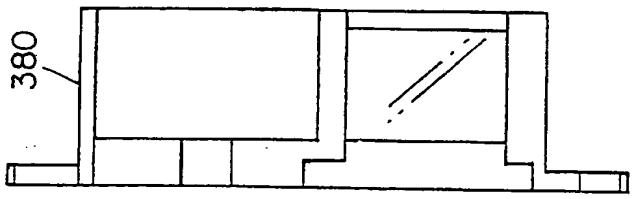


FIG. 5B

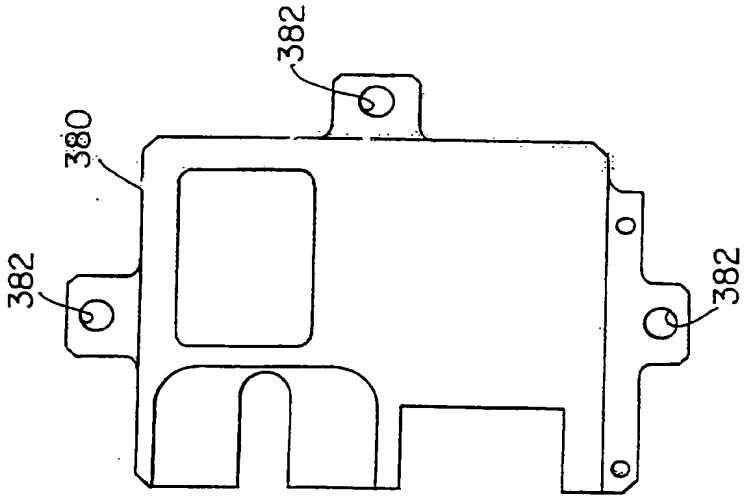
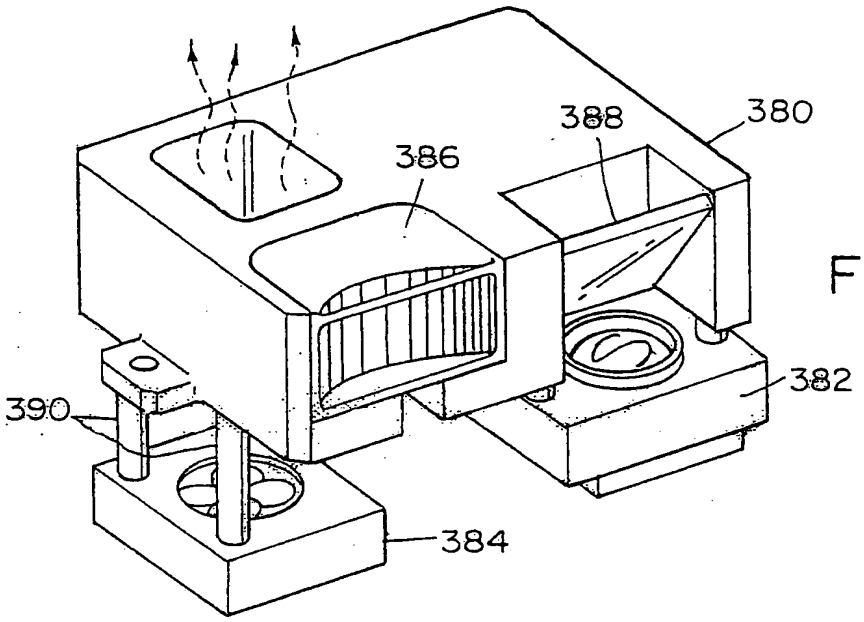


FIG. 5A


388
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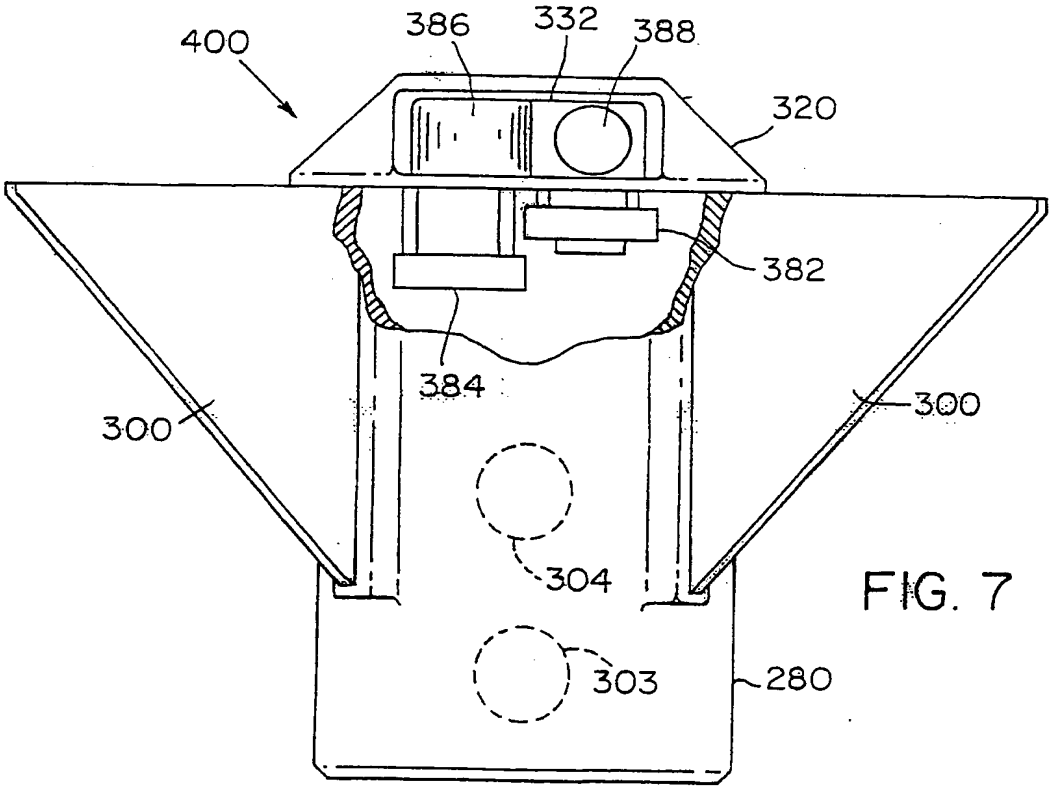
382
390
384

FIG. 6


400
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332
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280

FIG. 7

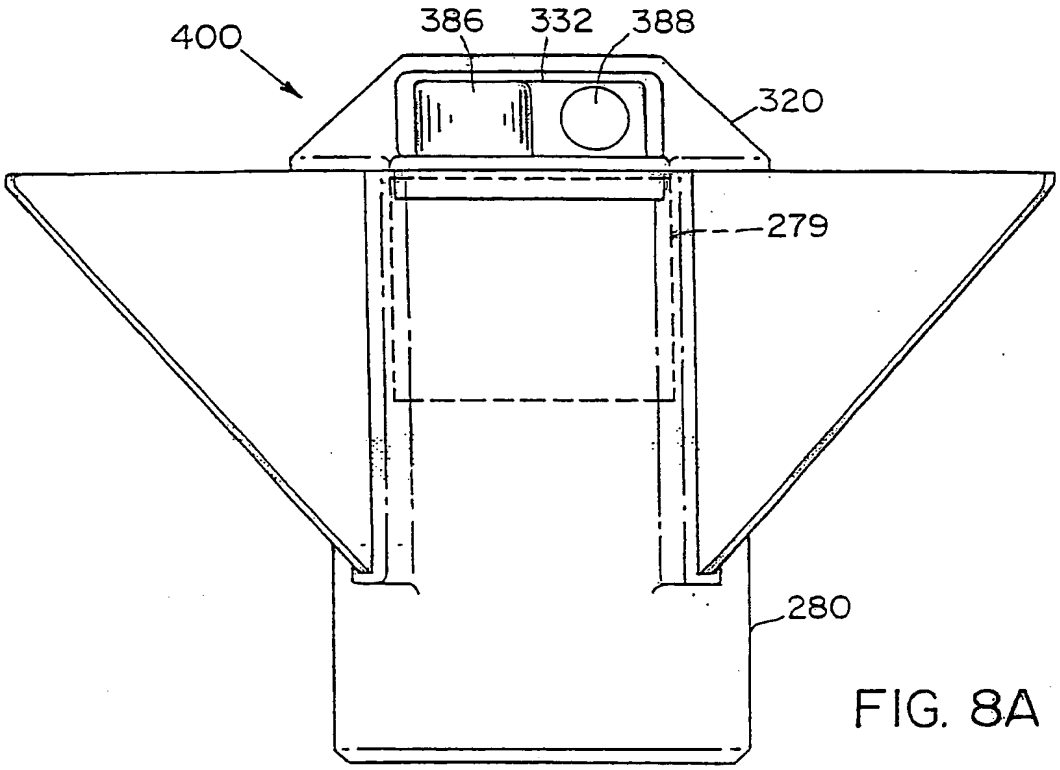

FIG. 8A

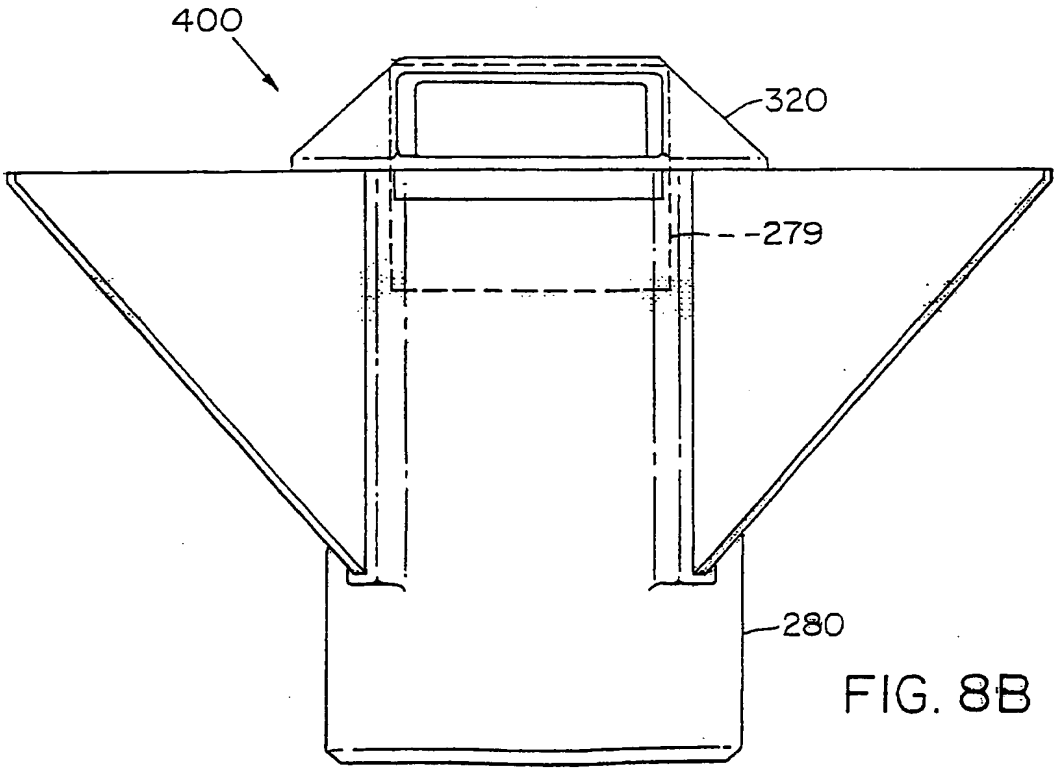

FIG. 8B

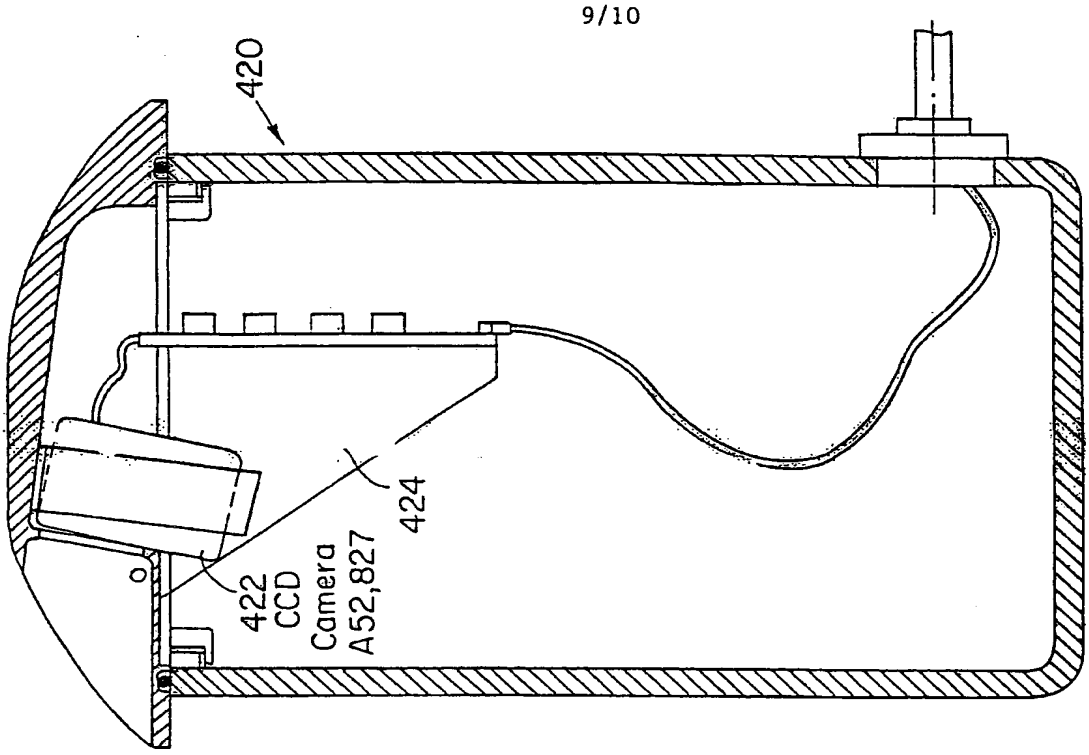
420
422
CCD
Camera
A52,827
424

FIG. 9B

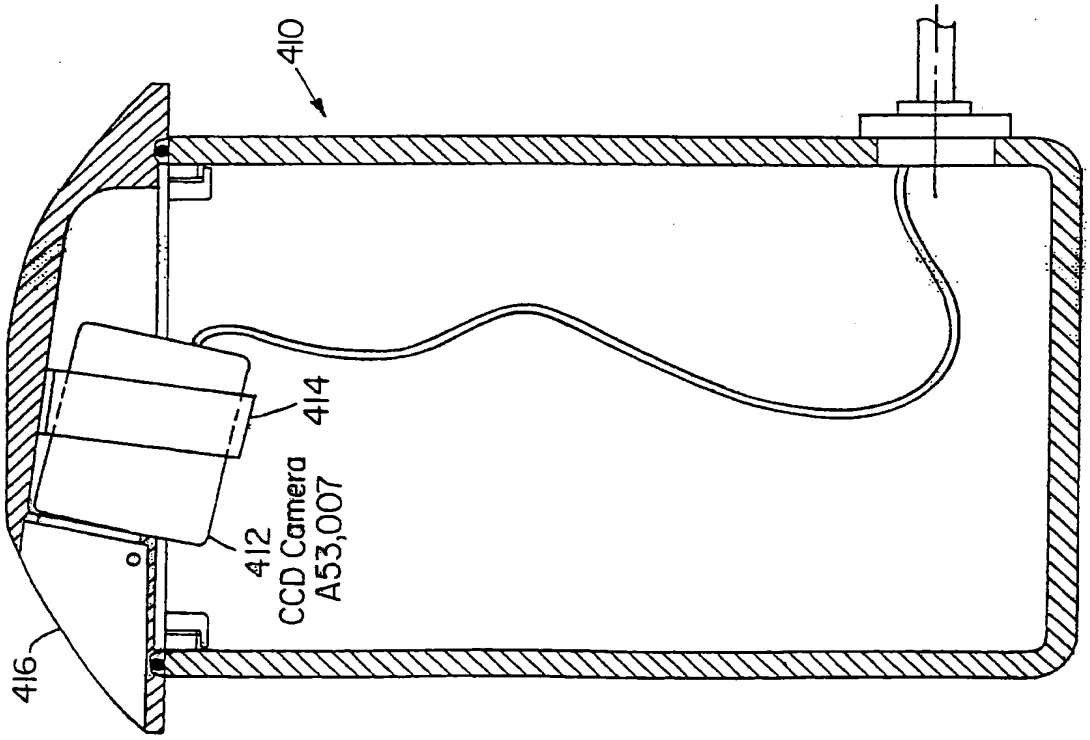
410
414
412
CCD Camera
A53,007
416

FIG. 9A

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 98/20857

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G08G1/017 G08G1/054

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 741 377 A (NEMESYS GES FUER NEUE MESSSYST) 6 November 1996 see abstract ---	1-5,12, 16,22-27
Y	GB 2 258 321 A (MORFAX LTD) 3 February 1993	1-5,12, 16,22, 24-27
A	see page 2, line 8 - page 5, line 23 see page 6, line 12 - page 8, line 6 see page 8, line 24 - page 9, line 3 see page 9, line 24 - line 27 see page 10, line 8 - line 23 ---	6-11,15, 17-19,21
Y	WO 93 19429 A (ICONIX PTY LTD) 30 September 1993 see abstract see page 18, line 11 - line 32; figure 11 --- -/--	4

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 March 1999	26/03/1999

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 98/20857

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication.where appropriate, of the relevant passages	Relevant to claim No.
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A	US 4 646 146 A (DEHUBRY FREDERICK ET AL) 24 February 1987 see abstract	3,14

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Interi nal Application No
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